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Standard Specification for Loadbearing Concrete Masonry Units[1]

This standard is issued under the fixed designation C 90; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This specification covers hollow and solid (see 5.3 and 5.4) concrete masonry units made from portland cement, water, and mineral aggregates with or without the inclusion of other materials. There are three classes of concrete masonry units: (1) normal weight, (2) medium weight, and (3) lightweight. These units are suitable for both loadbearing and nonloadbearing applications.

1.2 Concrete masonry units covered by this specification are made from lightweight or normal weight aggregates, or both.

1.3 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

NOTE 1—When particular features are desired such as surface textures for appearance or bond, finish, color, or particular properties such as weight classification, higher compressive strength, fire resistance, thermal performance or acoustical performance, these features should be specified separately by the purchaser. Local suppliers should be consulted as to the availability of units having the desired features.

2. Referenced Documents

2.1 *ASTM Standards:*

C 33 Specification for Concrete Aggregates[2]
C 140 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units[3]
C 150 Specification for Portland Cement[4]
C 331 Specification for Lightweight Aggregates for Concrete Masonry Units[2]
C 426 Test Method for Drying Shrinkage of Concrete Masonry Units[3]
C 595 Specification for Blended Hydraulic Cements[4]
C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete[2]
C 989 Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars[2]
C 1157 Performance Specification for Hydraulic Cement[4]
C 1209 Terminology of Concrete Masonry Units and Related Units[3]
C 1232 Terminology of Masonry[3]
C 1314 Test Method for Constructing and Testing Masonry Prisms Used to Determine Compliance with Specified Compressive Strength of Masonry[3]
E 519 Test Method for Diagonal Tension (Shear) in Masonry Assemblages[3]
E 72 Methods for Conducting Strength Tests of Panels for Building Construction[5]

3. Terminology

3.1 Terminology defined in Terminology C 1209 and Terminology C 1232 shall apply for this specification.

4. Materials

4.1 *Cementitious Materials*—Materials shall conform to the following applicable specifications:

4.1.1 *Portland Cement*—Specification C 150.

4.1.2 *Modified Portland Cement*—Portland cement conforming to Specification C 150, modified as follows:

(1) Limestone—If calcium carbonate is added to the cement, the $CaCO_3$ content shall not be less than 85 %.

(2) Limitation on Insoluble Residue—1.5 %.

(3) Limitation on Air Content of Mortar—Volume percent, 22 % max.

(4) Limitation on Loss on Ignition—7 %.

4.1.3 *Blended Hydraulic Cements*—Specification C 595.

4.1.4 *Hydraulic Cement*—Specification C 1157.

4.1.5 *Pozzolans*—Specification C 618.

4.1.6 *Blast Furnace Slag Cement*—Specification C 989.

4.2 *Aggregates*—Aggregates shall conform to the following specifications, except that grading requirements shall not necessarily apply:

4.2.1 *Normal Weight Aggregates*—Specification C 33.

[1] This specification is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.03 on Concrete Masonry Units and Related Units.

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[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] *Annual Book of ASTM Standards*, Vol 04.05.

[4] *Annual Book of ASTM Standards*, Vol 04.01.

[5] *Annual Book of ASTM Standards*, Vol 04.07.

***A Summary of Changes section appears at the end of this standard.**

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4.2.2 *Lightweight Aggregates*—Specification C 331.

4.3 *Other Constituents*—Air-entraining agents, coloring pigments, integral water repellents, finely ground silica, and other constituents shall be previously established as suitable for use in concrete masonry units and shall conform to applicable ASTM standards or shall be shown by test or experience not to be detrimental to the durability of the concrete masonry units or any material customarily used in masonry construction.

5. Physical Requirements

5.1 At the time of delivery to the purchaser, units shall conform to the physical requirements prescribed in Table 1 and Table 2.

NOTE 2—Higher compressive strengths than those listed in Table 2 may be specified where required by design. Consult with local suppliers to determine availability of units of higher compressive strength.

5.2 At the time of delivery to the purchaser, the linear shrinkage of units shall not exceed 0.065 %.

NOTE 3—The purchaser is the public body or authority, association, corporation, partnership, or individual entering into a contract or agreement to purchase or install, or both, concrete masonry units. The time of delivery to the purchaser is FOB plant when the purchaser or the purchaser's agent transports the concrete masonry units, or at the time unloaded at the worksite if the manufacturer or the manufacturer's agent transports the concrete masonry units.

5.3 *Hollow Units*:

5.3.1 Face shell thickness (t_{fs}) and web thickness (t_w) shall conform to the requirements prescribed in Table 1.

NOTE 4—Web thickness (t_w) not conforming to the requirements prescribed in Table 1 may be approved, provided equivalent structural capability has been established when tested in accordance with the applicable provisions of Test Methods E 72, C 1314, E 519, or other applicable tests and the appropriate design criteria developed is in accordance with applicable building codes.

TABLE 1 Minimum Thickness of Face Shells and Webs

Nominal Width (W) of Units, in. (mm)	Face Shell Thickness (t_{fs}), min, in. (mm)[A]	Web Thickness (t_w)	
		Webs[B] min, in. (mm)	Equivalent Web Thickness, min, in./linear ft[B,C] (mm/linear m)
3 (76.2) and 4 (102)	¾(19)	¾(19)	1⅝(136)
6 (152)	1 (25)[D]	1 (25)	2¼(188)
8 (203)	1¼ (32)[D]	1 (25)	2¼(188)
10 (254)	1⅜ (35)[D] 1¼ (32)[D,E]	1⅛ (29)	2½(209)
12 (305) and greater	1½ (38) 1¼ (32)[D,E]	1⅛ (29)	2½(209)

[A] Average of measurements on 3 units taken at the thinnest point when measured as described in Test Methods C 140. When this standard is used for split face units, not more than 10 % of a split face shell area shall be less than shown, and the face shell thickness in this area shall be not less than ¾ in. (19.1 mm). When the units are solid grouted the 10 % limit does not apply.

[B] Average of measurements on 3 units taken at the thinnest point when measured as described in Test Methods C 140. The minimum web thickness for units with webs closer than 1 in. (25.4 mm) apart shall be ¾ in. (19.1 mm).

[C] Sum of the measured thicknesses of all webs in the unit, multiplied by 12 and divided by the length of the unit. Equivalent web thickness does not apply to the portion of the unit to be filled with grout. The length of that portion shall be deducted from the overall length of the unit for the calculation of the equivalent web thickness.

[D] For solid grouted masonry construction, minimum face shell thickness shall be not less than ⅝ in. (16 mm).

[E] This face shell thickness (t_{fs}) is applicable where allowable design load is reduced in proportion to the reduction in thickness from basic face shell thicknesses shown, except that allowable design loads on solid grouted units shall not be reduced.

5.4 *Solid Units*:

5.4.1 The net cross-sectional area of solid units in every plane parallel to the bearing surface shall be not less than 75 % of the gross cross-sectional area measured in the same plane.

5.5 *End Flanges*:

5.5.1 For units having end flanges, the thickness of each flange shall not be less than the minimum face shell thickness.

NOTE 5—Flanges beveled at the ends for mortarless head joint applications that will be filled with grout are exempt from this requirement. Flanges which are specially shaped for mortarless head joint applications which have been shown by testing or field experience to provide equivalent performance are exempt from this requirement.

6. Permissible Variations in Dimensions

6.1 *Standard Units*—For standard units, no overall dimension (width, height, and length) shall differ by more than ±⅛ in. (3.2 mm) from the specified dimensions.

6.2 *Particular Feature Units*—For particular feature units, dimensions shall be in accordance with the following:

6.2.1 For molded face units, no overall dimension (width, height, and length) shall differ by more than ±⅛ in. (3.2 mm) from the specified standard dimension. Dimensions of molded features shall be within ±1⁄16 in. (1.6 mm) of the specified standard dimensions and shall be within ±1⁄16 in. (1.6 mm) of the specified placement of the molded feature.

NOTE 6—Molded features include, but are not limited to: ribs, scores, hex-shapes, and patterns.

6.2.2 For split-faced units, all non-split overall dimensions shall differ by not more than ±⅛ in. (3.2 mm) from the specified standard dimensions. On faces that are split, overall dimension will vary. Consult with local suppliers to determine achievable dimensional tolerances.

6.2.3 For slump units, no overall height dimension shall differ by more than ±⅛ in. (3.2 mm) from the specified standard dimension. On faces that are slumped, overall dimensions will vary. Consult with local suppliers to determine achievable dimensional tolerances.

7. Finish and Appearance

7.1 All units shall be sound and free of cracks or other defects that interfere with the proper placement of the unit or significantly impair the strength or permanence of the construction. Minor cracks, incidental to the usual method of manufacture or minor chipping resulting from customary methods of handling in shipment and delivery, are not grounds for rejection.

7.2 Where units are to be used in exposed wall construction, the face or faces that are to be exposed shall not show chips or cracks, not otherwise permitted, or other imperfections when viewed from a distance of not less than 20 ft (6.1 m) under diffused lighting.

7.2.1 Five percent of a shipment containing chips, not larger than 1 in. (25.4 mm) in any dimension, or cracks not wider than 0.02 in. (0.5 mm) and not longer than 25 % of the nominal height of the unit, is permitted.

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TABLE 2 Strength and Absorption Requirements

Compressive Strength,[A] min, psi (MPa)		Water Absorption, max, lb/ft^3 (kg/m^3) (Average of 3 Units)		
Average Net Area		Weight Classification—Oven-Dry Weight of Concrete, lb/ft^3(kg/m^3)		
Average of 3 Units	Individual Unit	Lightweight, less than 105 (1680)	Medium Weight, 105 to less than 125 (1680–2000)	Normal Weight, 125 (2000) or more
1900 (13.1)	1700 (11.7)	18 (288)	15 (240)	13 (208)

[A] Higher compressive strengths may be specified where required by design. Consult with local suppliers to determine availability of units of higher compressive strength.

7.3 The color and texture of units shall be specified by the purchaser. The finished surfaces that will be exposed in place shall conform to an approved sample, consisting of not less than four units, representing the range of texture and color permitted.

7.4 A shipment shall not contain more than 5 % of units, including broken units, that do not meet the requirements of 6.1, 7.1, 7.2, and 7.2.1.

8. Sampling and Testing

8.1 The purchaser or authorized representative shall be accorded proper facilities to inspect and sample the units at the place of manufacture from the lots ready for delivery.

8.2 Sample and test units in accordance with Test Methods C 140.

8.3 Total linear drying shrinkage shall be based on tests of concrete masonry units made with the same materials, concrete mix design, manufacturing process, and curing method, conducted in accordance with Test Method C 426 and not more than 24 months prior to delivery.

9. Compliance

9.1 If a sample fails to conform to the specified requirements, the manufacturer shall be permitted to remove units from the shipment. A new sample shall be selected by the purchaser from remaining units from the shipment with a similar configuration and dimension and tested at the expense of the manufacturer. If the second sample meets the specified requirements, the remaining portion of the shipment represented by the sample meets the specified requirements. If the second sample fails to meet the specified requirements, the remaining portion of the shipment represented by the sample fails to meet the specified requirements.

NOTE 7—Unless otherwise specified in the purchase order, the cost of tests is typically borne as follows: (1) if the results of the tests show that the units do not conform to the requirements of this specification, the cost is typically borne by the seller; (2) if the results of the tests show that the units conform to the specification requirements, the cost is typically borne by the purchaser.

10. Keywords

10.1 absorption; concrete masonry units; equivalent web thickness; face shell; flange; lightweight; linear shrinkage; loadbearing; medium weight; normal weight; webs

APPENDIXES

(Nonmandatory Information)

X1. WATER PENETRATION RESISTANCE

X1.1 Exterior walls are often subjected to moisture penetration from one or more sources. For example, basement walls may be exposed to water from saturated soil. Above-grade exterior walls are usually exposed to wind-driven rain. To prevent water penetration, proper detailing, construction, flashing, and drainage should be provided. Proper water penetration resistant treatments should be applied to the walls. While it is not within the scope of Specification C 90 to include information on resistance to water penetration, such information and guidelines are available from other organizations.

X2. CRACK CONTROL

X2.1 Restrained or differential movement in building elements and building materials can result in cracking. Some common causes of movement are: loads created by wind, soil pressure, seismic forces, or other external sources; settlement of foundations; or volume changes in materials. For example, volume changes in concrete masonry units can be caused by moisture gain and loss, thermal expansion and contraction, and carbonation. To limit and control cracking due to these and other causes, proper design, detailing, construction, and materials are necessary. Specification C 90 provides a maximum limitation on the total linear drying shrinkage potential of the units, but it is not within the scope of this specification to address other design, detailing, construction, or material recommendations. This type of information and related guidelines for crack control are available from other organizations.

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SUMMARY OF CHANGES

Committee C15 has identified the location of selected changes to this standard since C 90-02 that may impact the use of this standard.

(1) Section 4.1.2 was revised to remove permissive language.
(2) Note A of Table 1 was revised to remove permissive language.
(3) Changes to Appendix X2 on Crack Control removed implication that cracking in masonry can be prevented.

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